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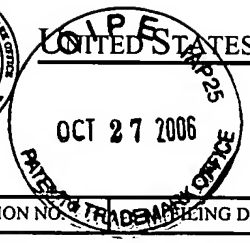

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APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.	CONFIRMATION NO.
10/621,109	07/16/2003	Richard Tango-Lowy	COGNITA-001XX	9090

28452 7590 10/23/2006

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EXAMINER	
COUGHLAN, PETER D	
ART UNIT	**PAPER NUMBER**
2129	

DATE MAILED: 10/23/2006

Please find below and/or attached an Office communication concerning this application or proceeding.

Office Action Summary	Application No.	Applicant(s)	
	10/621,109	TANGO-LOWY, RICHARD	
	Examiner	Art Unit	
	Peter Coughlan	2129	

-- The MAILING DATE of this communication appears on the cover sheet with the correspondence address --

Period for Reply

A SHORTENED STATUTORY PERIOD FOR REPLY IS SET TO EXPIRE 3 MONTH(S) OR THIRTY (30) DAYS, WHICHEVER IS LONGER, FROM THE MAILING DATE OF THIS COMMUNICATION.

- Extensions of time may be available under the provisions of 37 CFR 1.136(a). In no event, however, may a reply be timely filed after SIX (6) MONTHS from the mailing date of this communication.
- If NO period for reply is specified above, the maximum statutory period will apply and will expire SIX (6) MONTHS from the mailing date of this communication.
- Failure to reply within the set or extended period for reply will, by statute, cause the application to become ABANDONED (35 U.S.C. § 133). Any reply received by the Office later than three months after the mailing date of this communication, even if timely filed, may reduce any earned patent term adjustment. See 37 CFR 1.704(b).

Status

1)☒ Responsive to communication(s) filed on *07 August 2006*.

2a)☒ This action is **FINAL**. 2b)☐ This action is non-final.

3)☐ Since this application is in condition for allowance except for formal matters, prosecution as to the merits is closed in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11, 453 O.G. 213.

Disposition of Claims

4)☒ Claim(s) *1-13* is/are pending in the application.

4a) Of the above claim(s) _____ is/are withdrawn from consideration.

5)☐ Claim(s) _____ is/are allowed.

6)☒ Claim(s) *1-13* is/are rejected.

7)☐ Claim(s) _____ is/are objected to.

8)☐ Claim(s) _____ are subject to restriction and/or election requirement.

Application Papers

9)☐ The specification is objected to by the Examiner.

10)☒ The drawing(s) filed on *7/16/2003* is/are: a)☒ accepted or b)☐ objected to by the Examiner.

Applicant may not request that any objection to the drawing(s) be held in abeyance. See 37 CFR 1.85(a).

Replacement drawing sheet(s) including the correction is required if the drawing(s) is objected to. See 37 CFR 1.121(d).

11)☐ The oath or declaration is objected to by the Examiner. Note the attached Office Action or form PTO-152.

Priority under 35 U.S.C. § 119

12)☐ Acknowledgment is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d) or (f).

a)☐ All b)☐ Some * c)☐ None of:

1.☐ Certified copies of the priority documents have been received.

2.☐ Certified copies of the priority documents have been received in Application No. _____.

3.☐ Copies of the certified copies of the priority documents have been received in this National Stage application from the International Bureau (PCT Rule 17.2(a)).

* See the attached detailed Office action for a list of the certified copies not received.

Attachment(s)

1) ☒ Notice of References Cited (PTO-892)
2) ☐ Notice of Draftsperson's Patent Drawing Review (PTO-948)
3) ☐ Information Disclosure Statement(s) (PTO/SB/08) Paper No(s)/Mail Date _____.
4) ☐ Interview Summary (PTO-413) Paper No(s)/Mail Date. _____.
5) ☐ Notice of Informal Patent Application
6) ☐ Other: _____.

Detailed Action

1. This office action is in response to an AMENDMENT entered August 7, 2006 for the patent application 10/621109 filed on July 16, 2003.

2. The First Office Action of February 6, 2006 is fully incorporated into this Final Office Action by reference.

Status of Claims

3. Claims 1-13 are pending.

Claim Rejections - 35 USC § 112

4. The following is a quotation of the first paragraph of 35 U.S.C. 112:

> The specification shall contain a written description of the invention, and of the manner and process of making and using it, in such full, clear, concise, and exact terms as to enable any person skilled in the art to which it pertains, or with which it is most nearly connected, to make and use the same and shall set forth the best mode contemplated by the inventor of carrying out his invention.

Claims 1, 6, 7, 12 and 13 rejected under 35 U.S.C. 112, first paragraph, as failing to comply with the enablement requirement. The claim(s) contains subject matter which was not described in the specification in such a way as to enable one skilled in the art to which it pertains, or with which it is most nearly connected, to make and/or use the

invention. Claims 1, 6, 7, 12 and 13 use the term "one character grouping" which is not defined in the specification.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claims 1-13 are rejected under 35 U.S.C. 103(a) as being unpatentable over Miller et al in view of Inoue, and further in view of Mehrotra (U. S. Patent Publication 20020026369, referred to as **Miller**; U. S. Patent 5402519, referred to as **Inoue**; 'Elements of Neural Networks', referred to as **Mehrotra**).

Claims 1, 2, 6, 7, 8, 12 and 13.

Miller teaches a user interface, for receiving requests for information and for receiving answer feedback, information (**Miller,** ¶0048, ¶0211 and ¶0221)

Miller does not teach an answer table containing a plurality of answers to possible requests for information, each said plurality of answers including at least one

character grouping; a symbol table containing a plurality of unique symbols, each said plurality of unique symbols corresponding to one of said at least one character grouping of one answer in said answer table; a neuron table including a plurality of weightable links , each said weightable link corresponding to a weightable link between one of said plurality of unique symbols in said symbol table and one or more of said answers in said answer table. Inoue teaches an answer table containing a plurality of answers to possible requests for information, each said plurality of answers including at least one character grouping. (**Inoue,** C4:13-28 and 51-57; Examiner's Note (EN) 'Answer table' of applicant is equivalent to 'fuzzy membership functions' of Inoue. 'One character grouping' of applicant would be at least one answer of the fuzzy logic functions.) It would have been obvious to a person having ordinary skill in the art at the time of applicant's invention to modify teachings of Miller by using a fuzzy logic input to generate possible requests for information as taught by Inoue to have an answer table containing a plurality of answers to possible requests for information, each said plurality of answers including at least one character grouping.

For the purpose of generating one or more possible requests for a given input which fuzzy logic function can provide.

Inoue teaches a symbol table containing a plurality of unique symbols, each said plurality of unique symbols corresponding to one of said at least one character grouping of one answer in said answer table. (**Inoue,** C4:58 through C5:3; EN 'Answer table' of applicant is equivalent to 'forward neural network' of Inoue. The unique symbols of applicant would be the resulting answers from the forward feeding

neural network.) It would have been obvious to a person having ordinary skill in the art at the time of applicant's invention to modify teachings of Miller by having a neural network that can easily produce a resulting symbol from the character grouping input from the fuzzy logic functions as taught by Miller to have a symbol table containing a plurality of unique symbols, each said plurality of unique symbols corresponding to one of said at least one character grouping of one answer in said answer table.

For the purpose of refining or narrowing the scope of the answer with the given data and being able to train or modify the symbol table as needs change.

Inoue teaches a neuron table including a plurality of weightable links , each said weightable link corresponding to a weightable link between one of said plurality of unique symbols in said symbol table and one or more of said answers in said answer table. (**Inoue,** Figure #1 AND C8:7-29; EN 'Weightable links' of applicant is equivalent to 'weight-correcting section' of Inoue. Figure #1 clearly shows the 'weightable links' is between the answer table (fuzzy logic) and symbol table (neural network).) It would have been obvious to a person having ordinary skill in the art at the time of applicant's invention to modify teachings of Miller by having correcting/adjusting weights for the neural network so training and modification can occur as taught by Inoue to have a neuron table including a plurality of weightable links , each said weightable link corresponding to a weightable link between one of said plurality of unique symbols in said symbol table and one or more of said answers in said answer table.

For the purpose of having the symbol table produce a correct outcome with a given input and have the ability to learn/modify.

Miller teaches a search engine, responsive to said user interface and to a received request for information, for parsing said received request into one or more query stimuli (**Miller,** abstract), for searching said symbol table for one or more unique symbols matching at least one of said one or more query stimuli, responsive to one or more matching unique answer symbols, for searching said neuron table to determine an answer responsiveness weight based upon individual answer symbol weightable links obtained from said neuron table for each of said one of more answers in said answer table having a weightable link between one of said plurality of unique symbols in said symbol table, and for presenting to said user one or more possible answers to said requested information based upon said determined answer responsiveness weight.

Miller does not teach a learning engine, responsive to said answer feedback, for increasing or decreasing said weightable link weight between unique symbols and said one or more answers and/or at least one specific answer.

Inoue teaches a learning engine, responsive to said answer feedback, for increasing or decreasing said weightable link weight between unique symbols and said one or more answers and/or at least one specific answer. (**Inoue,** C2:56-66; EN 'Increasing or decreasing' of applicant is equivalent to 'adjusting' of Inoue.) It would have been obvious to a person having ordinary skill in the art at the time of applicant's invention to modify teachings of Miller by describing in more detail of how a neural network learns from feedback by adjusting weights as taught by Inoue to have a learning engine, responsive to said answer feedback, for increasing or decreasing

said weightable link weight between unique symbols and said one or more answers and/or at least one specific answer.

For the purpose of the user having control of the system to respond in a way the user prefers.

Miller teaches receiving new answer information, said new answer information containing at least one character grouping. (**Miller,** ¶0221; EN 'New answer information' of applicant is equivalent to 'feedback' of Miller)

Miller does not teach adding said new answer information to said answer table,

parsing said at least one character grouping of said new answer information into at least one unique symbol, adding said unique symbol to said symbol table if said unique symbol is not already in said symbol table and generating a new weightable link between said unique symbol and said new answer information, generating a new weightable link between a previously existing unique symbol and said new answer information if said unique symbol is already in said symbol table.

Inoue teaches adding said new answer information to said answer table. (**Inoue,** C8:30 through C9:4; EN 'New answer information' of applicant is equivalent to 'input information' of Inoue. Depending on what type of new answer information is inputted, Inoue has 3 ranges of membership functions to chose from.) It would have been obvious to a person having ordinary skill in the art at the time of applicant's invention to modify teachings of Miller by having the ability to pick the range of adaptability of fuzzy function per a given Xi as taught by Inoue to add new answer information to said answer table.

For the purpose of having a flexible system because input information does not remain constant.

Inoue teaches parsing said at least one character grouping of said new answer information into at least one unique symbol, adding said unique symbol to said symbol table if said unique symbol is not already in said symbol table and generating a new weightable link between said unique symbol and said new answer information, generating a new weightable link between a previously existing unique symbol and said new answer information if said unique symbol is already in said symbol table. (**Inoue,** C2:24-37; EN Parsing input generates output from the neural network. 'One unique symbol' of applicant is equivalent to 'new state' of Inoue. 'Weightable link' is equivalent to 'coupling coefficients' of Inoue.) It would have been obvious to a person having ordinary skill in the art at the time of applicant's invention to modify the teachings of Miller by having input value of at least one character grouping resulting into a symbol. If a current symbol is not precise a new symbol (output value) is generated along with all the adjusting weights as taught by Inoue to have said at least one character grouping of said new answer information into at least one unique symbol, adding said unique symbol to said symbol table if said unique symbol is not already in said symbol table and generating a new weightable link between said unique symbol and said new answer information, generating a new weightable link between a previously existing unique symbol and said new answer information if said unique symbol is already in said symbol table.

For the purpose of having a system that can expand as needed.

Claims 3, 4, 5, 9, 10 and 11.

Miller and Inoue do not teach learning engine strengthens one or more weightable links that match unique symbols to a selected answer; learning engines weakens said weightable links; learning engine weakens weightable links that match unique symbols to one or more non-selected answers.

Mehrotra teaches a learning engine strengthens one or more weightable links that match unique symbols to a selected answer; learning engines weakens said weightable links; learning engine weakens weightable links that match unique symbols to one or more non-selected answers (**Mehrotra,** page 22:16-24; EN Mehrotra illustrates there is a direct correlation between the weights (strength of connection) and outputs. So if input is to match a unique symbol, the link is strengthen (increased). If the correlation is between input and non-selected answers(incorrect) the link is weakened (decreased).) It would have been obvious to a person having ordinary skill in the art at the time of applicant's invention to modify combined teachings of Miller and Inoue by using standardized methods for training a neural network as taught by Mehrotra to have a learning engine strengthens one or more weightable links that match unique symbols to a selected answer; learning engines weakens said weightable links; learning engine weakens weightable links that match unique symbols to one or more non-selected answers.

For the purpose of training a neural network to produce correct answers with a given input.

Response to Arguments

5. Applicant's arguments filed on August 7, 2006 for claims 1-13 have been fully considered but are not persuasive.

6. In reference to the Applicant's argument:

Applicant appreciates the examiner's review of the present application and requests reconsideration in view of the preceding amendment and the following remarks. Claims 1-13 are pending in the present application.

The examiner has rejected claims 1, 6, 7 and 13 stating that the "search engine" mentions a symbol table and neuron table in the claim although figure 1 clearly shows these tables contained within the "teaching engine". Applicant requests reconsideration. Figure 1 is meant to visually describe what tables are associated with what engine. This is not a limitation of the present invention however. For example, as is disclosed in paragraph 0028 through paragraph 0031, the searching engine logic 16 has tables which are related to the search engine. This does not mean that the search engine cannot use other tables. A search engine, by its very name and nature, performs the function of searching some location for some information. The presentation in figure 1 does not preclude the search engine from searching a symbol table or a neuron table logically associated with another portion of the invention. These are simply other tables that are associated with other parts of the present invention. Accordingly, this rejection should be withdrawn.

Examiner's response:

First Office Action applies.

7. In reference to the Applicant's argument:

The examiner next rejects claims 1, 6, 7, 12 and 13 under 35 U.S.C. § 112, first paragraph, as failing to comply with the enablement requirement. The examiner states that the claims contain subject matter which was not described in the specification in such a way as to enable one skilled in the art to make and/or use the invention. More specifically, the examiner states that claims 12 and 13 use the term "new answer information" which is not defined in the specification while claims 1, 6, 7, 12 and 13 use the term "one character grouping" which is not defined in the specification. Applicants traverse this rejection for the reason set forth below.

With regard to the term "new answer information" the examiner is directed to at least paragraphs 0033 through paragraph 0034 and to element 100, figures 2 and 3 which show how "new" answer information 100 is added to existing answer information table 20. Accordingly, this answer information being supplied is "new" answer information being "added" to the system. This is clearly described in the specification and this rejection should be withdrawn.

With regard to the term "one character grouping" applicant also traverses this rejection. The term "character grouping" means a string of characters grouped together. Typically, a character grouping is a word but this is not necessarily so. For example, as shown in figure 2, any answer 20 includes a summary which is defined as a variable character of up to 255 places. Ultimately, this same character grouping or at least a portion thereof allowing it to be searchable, is inserted in the symbol table 22, figure 2. This is also described in the specification beginning on page 13, paragraph 0050 through page 15, paragraph 0054. Having reference to table 1 and table 2 found on page 14 illustrates that the "symbol" in both the symbol table and the answer table includes at least one "character grouping" which in the illustration, are words. Accordingly, applicant urges that the specification clearly supports and enables this recitation in the claims and therefore, the rejection should be withdrawn.

Examiner's response:

The Examiner withdraws the 35 U.S.C. § 112 rejection for claims containing the phrase 'new answer information'. However, the Examiner maintains the 35 U.S.C. § 112 rejection for the phrase 'one character grouping'. The closest match/explanation for this term is in ¶0055. The term used is 'space-delimited character-grouping' which does not map well to 'one character grouping.' The word 'character' and the word 'grouping' only appear in ¶0055.

8. In reference to the Applicant's argument:

The claims stand rejected under 35 USC 103 under Miller et al. in view of Inoue et al. Miller shows a "system for product identification." Inoue teaches a "Neural network system adapted for non-linear processing." The disparate nature of the references alone is astounding. Each invention teaches different functionality, that operate for completely different purposes, that interface with the operator in different manners, and that are coded in different software systems. Neither reference teaches a method of dynamically relating unstructured requests for information as claimed by the applicant, much less can it be said that there are actual statements in the references rising to the level of a motivation to combine the references to obtain the claims of the invention.

Examiner's response:

While the prior references may seem to be disparate in Nature, the inherent technology reprised by the prior art and to one of ordinary skill in the art is consistence with solving problems relating to database queries. Applicant makes the claim 'Neither reference teaches a method of dynamically relating unstructured requests.' This is in the preamble of the claim and not given much weight. See MPEP 7.37.10 for more information.

9. In reference to the Applicant's argument:

The Federal Circuit has repeatedly warned against using the applicant's disclosure as a blueprint to reconstruct the claimed invention out of isolated teachings in the prior art. See, e.g., Grain Processing Corp. v. American Maize-Products, 840 F2d. 902, 907, 5 USPQ2d 1788, 1792 (Fed. Cir. 1988). The black letter law statements by Judge Linn in In re Kotzab, 217 F.3d 1365, 55 USPQ2d 1313 (Fed.

Cir. 2000) address this subject regarding hindsight. A critical step in analyzing the patentability of claims pursuant to section 103(a) is casting the mind back to the time of invention, to consider the thinking of one of ordinary skill in the art, guided only by the prior art references and the then-accepted wisdom in the field.Close adherence to this methodology is especially important in cases where the very ease with which the invention can be understood may prompt one "to fall victim to the insidious effect taught is used against the teacher." (Id. At 1369, 55 USPQ2d at 1316).

Examiner's response:

In response to Applicant's argument that there is no suggestion to combine the references, the Examiner recognizes that references cannot be arbitrarily combined and that there must be some reason why one skilled in the art would be motivated to make the proposed combination of references. In re Nomiya, 184 USPQ 607 (CCPA 1975). However, there is no requirement that a motivation to make the modification be expressly articulated. The test for combining references is not what individual references themselves suggest but rather what the combination of disclosures taken as a whole would suggest to one of ordinary skill in the art. In re Keller, 648 F.2d 413, 208 USPQ 871 (CCPA 1981); In re Sernaker, 702 F.2d 989, 217 USPQ 1 (Fed. Cir. 1983); In re McLaughlin, 170 USPQ 209 (CCPA 1971). References are evaluated by what they suggest to one versed in the art, rather than by their specific disclosures. In re Bozek, 163 USPQ 545 (CCPA 1969)..

10. In reference to the Applicant's argument:

The Examination cites to Miller as disclosing receiving feedback information. See ¶0048, ¶0211, ¶0221. However, this feedback does not at all relate to

characteristics of the search. The feedback collected is used to identify other products/coupons that would be of interest to the user. The feedback does not relate to the search. The notion of this feedback being used to refine the search seems to be one made expressly in hindsight for the sole purpose of combining the references. The disparate nature of the references and lack of motivation fail to provide a prima face case of obviousness. Accordingly, the rejections to the claims should be withdrawn.

Examiner's response:

The applicant does not state which questions this is referring to but the Examiner assumes it relates to claims 6 and 8. Applicant claims that feedback does not relate to the search. Examiner disagrees, Miller's feedback is from users which are directly related to the search. (**Miller,** ¶0048, ¶0211 and ¶0221: If feedback is given then it is 'related' to the search.)

Examination Considerations

11. The claims and only the claims form the metes and bounds of the invention. "Office personnel are to give the claims their broadest reasonable interpretation in light of the supporting disclosure. *In re Morris*, 127 F.3d 1048, 1054-55, 44USPQ2d 1023, 1027-28 (Fed. Cir. 1997). Limitations appearing in the specification but not recited in the claim are not read into the claim. *In re Prater*, 415 F.2d, 1393, 1404-05, 162 USPQ 541, 550-551 (CCPA 1969)" (MPEP p 2100-8, c 2, l 45-48; p 2100-9, c 1, l 1-4). The Examiner has the full latitude to interpret each claim in the broadest reasonable sense. Examiner will reference prior art using terminology familiar to one of ordinary skill in the

art. Such an approach is broad in concept and can be either explicit or implicit in meaning.

12. Examiner's Notes are provided to assist the applicant to better understand the nature of the prior art, application of such prior art and, as appropriate, to further indicate other prior art that maybe applied in other office actions. Such comments are entirely consistent with the intent and sprit of compact prosecution. However, and unless otherwise stated, the Examiner's Notes are not prior art but link to prior art that one of ordinary skill in the art would find inherently appropriate.

13. Examiner's Opinion: Paragraphs 11 and 12 apply. The Examiner has full latitude to interpret each claim in the broadest reasonable sense.

Conclusion

14. Applicant's amendment necessitated the new ground(s) of rejection presented in this Office action. Accordingly, **THIS ACTION IS MADE FINAL**. See MPEP § 706.07(a). Applicant is reminded of the extension of time policy as set forth in 37 CFR 1.136(a).

A shortened statutory period for reply to this final action is set to expire THREE MONTHS from the mailing date of this action. In the event a first reply is filed within

TWO MONTHS of the mailing date of this final action and the advisory action is not mailed until after the end of the THREE-MONTH shortened statutory period, then the shortened statutory period will expire on the date the advisory action is mailed, and any extension fee pursuant to 37 CFR 1.136(a) will be calculated from the mailing date of the advisory action. In no event, however, will the statutory period for reply expire later than SIX MONTHS from the date of this final action.

15. Claims 1-13 are rejected.

Correspondence Information

16. Any inquiry concerning this information or related to the subject disclosure should be directed to the Examiner Peter Coughlan, whose telephone number is (571) 272-5990. The Examiner can be reached on Monday through Friday from 7:15 a.m. to 3:45 p.m.

If attempts to reach the Examiner by telephone are unsuccessful, the Examiner's supervisor David Vincent can be reached at (571) 272-3687. Any response to this office action should be mailed to:

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(571) 273-8300 (for formal communications intended for entry.)

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Peter Coughlan

10/12/2006

JOSEPH P HIRL
PRIMARY EXAMINER
TECHNOLOGY CENTER 2100

Notice of References Cited	Application/Control No. 10/621,109	Applicant(s)/Patent Under Reexamination TANGO-LOWY, RICHARD	
	Examiner Peter Coughlan	Art Unit 2129	Page 1 of 1

U.S. PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Name	Classification
*	A	US-2002/0026369	02-2002	Miller et al.	705/26
*	B	US-5,402,519	03-1995	Inoue et al.	706/16
	C	US-			
	D	US-			
	E	US-			
	F	US-			
	G	US-			
	H	US-			
	I	US-			
	J	US-			
	K	US-			
	L	US-			
	M	US-			

FOREIGN PATENT DOCUMENTS

*		Document Number Country Code-Number-Kind Code	Date MM-YYYY	Country	Name	Classification
	N					
	O					
	P					
	Q					
	R					
	S					
	T					

NON-PATENT DOCUMENTS

*		Include as applicable: Author, Title Date, Publisher, Edition or Volume, Pertinent Pages)
	U	'Elements of Artificial Neural Networks', Mehrotra, Mohan, Ranka, 1997, MIT Press, p22
	V	
	W	
	X	

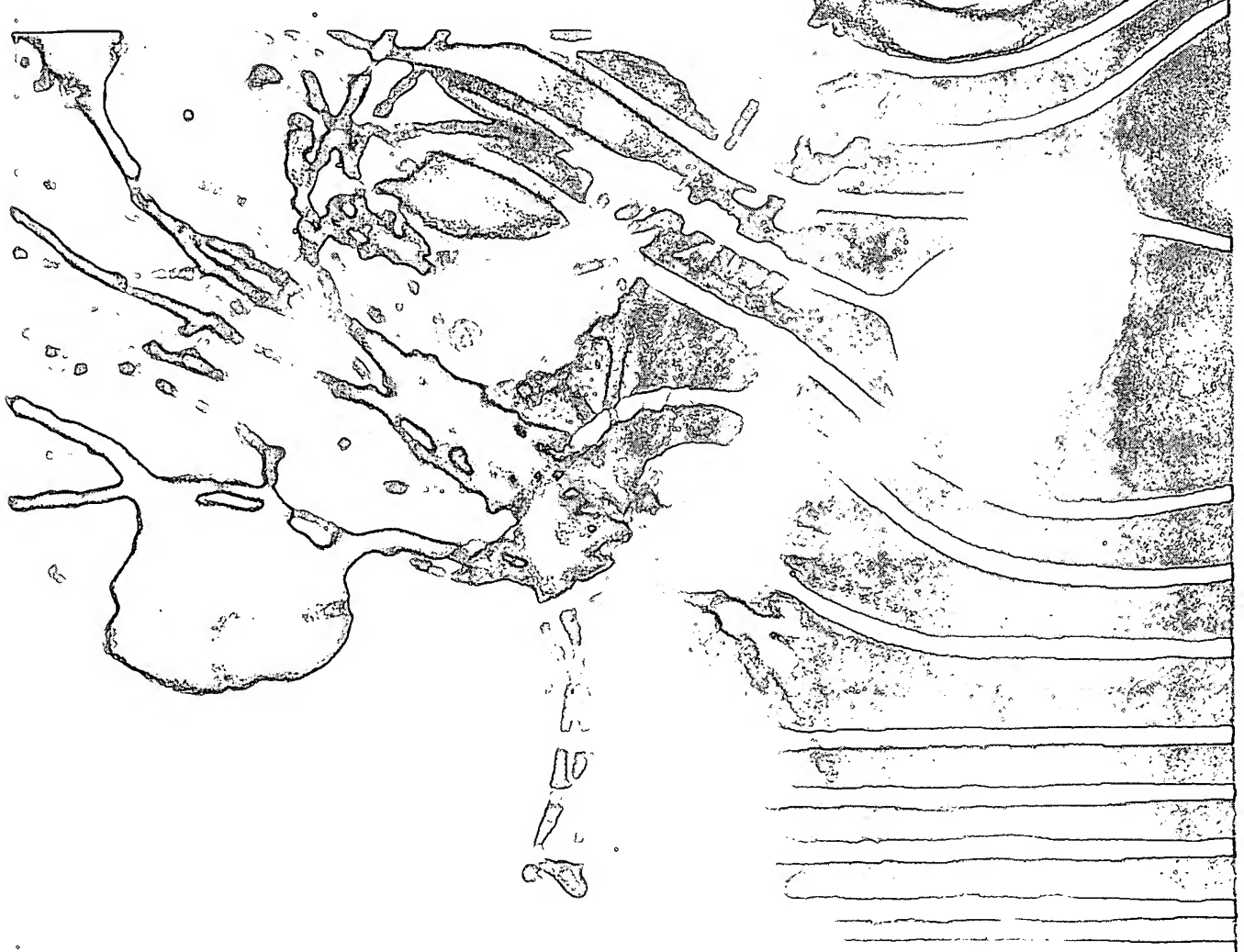
*A copy of this reference is not being furnished with this Office action. (See MPEP § 707.05(a).)
Dates in MM-YYYY format are publication dates. Classifications may be US or foreign.

Elements of Artificial Neural Networks

Kishan Mehrotra

Chilukuri K. Mohan

Sanjay Ranka



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Chilukuri K. Mohan, Sanjay Ranka.
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Includes bibliographical references and index.
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1. Neural networks (Computer science) I. Mohan, Chilukuri K.
II. Ranka, Sanjay. III. Title. IV. Series.
QA76.87.M45 1996
006.3—dc20 96-20178
CIP

For

Rama,
Sudha,
and
Deepa

1.4 Neural Learning

It is reasonable to conjecture that neurons in an animal's brain are "hard wired." It is equally obvious that animals, especially the higher order animals, learn as they grow. How does this learning occur? What are possible mathematical models of learning? In this section, we summarize some of the basic theories of biological learning and their adaptations for artificial neural networks. In artificial neural networks, learning refers to the method of modifying the weights of connections between the nodes of a specified network.

1.4.1 Correlation learning

One of the oldest and most widely known principles of biological learning mechanisms was described by Hebb (1949), and is sometimes called "Hebbian learning." Hebb's principle is as follows.

When an axon of cell A is near enough to excite a cell B and repeatedly or persistently takes place in firing it, some growth process or metabolic change takes place in one or both cells such that A's efficiency, as one of the cells firing B, is increased.

For artificial neural networks, this implies a gradual increase in strength of connections among nodes having similar outputs when presented with the same input. The strength of connections between neurons eventually comes to represent the correlation between their outputs. The simplest form of this weight modification rule for artificial neural networks can be stated as

$$\Delta w_{i,j} = c\, x_i\, x_j \tag{1.6}$$

where c is some small constant, denotes the strength of the connection from the jth node to the ith node, and x_i and x_j are the activation levels of these nodes. Many modifications of this rule have been developed and are widely used in artificial neural network models. Networks that use this type of learning are described in chapter 6.

1.4.2 Competitive learning

Another principle for neural computation is that when an input pattern is presented to a network, different nodes compete to be "winners" with high levels of activity. The competitive process involves self-excitation and mutual inhibition among nodes, until a single winner emerges. The connections between input nodes and the winner node are then modified, increasing the likelihood that the same winner continues to win in future